Creating a Task-Level Organization for an Autonomous Oceanographic Sampling Network

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LONG-TERM GOALS

Our long-term goal is to contribute to the technology needed to field Autonomous Oceanographic Sampling Networks (AOSNs) [1]. In particular, we are interested in finding ways to autonomously organize and reorganize AOSNs so that they can be "open systems" [2], comprised of a variety of components which may enter or exit at any time during deployment.

OBJECTIVES

In this project, we wish to automate the process of organizing the system by allowing the system to choose the organizational structure (e.g., hierarchy, contract net [3]) and then assigning components of the AOSN to carry out the tasks in that structure. To accomplish this, we have two specific objectives:

- Develop a method for selecting an appropriate organizational structure for a particular situation.
- Develop a mechanism to assign tasks in the organizational structure to the vehicle and non-mobile instrument platforms (VIPs) in the AOSN.

APPROACH

We take a two-pronged approach to our problem, corresponding to the two objectives listed above. To achieve the first, we will review the literature on organizations. For selected organizations, we will specify the characteristics of the missions, AOSNs and environments for which they are most and least appropriate. We will create a vocabulary of features so a particular AOSN, with a given mission, in a specific environment can be easily characterized. We will then develop a mechanism to select an appropriate organization for the AOSN.

To achieve the second objective, we are using a constraint-based approach for task assignment. For many missions, there are several ways to divide the mission into smaller tasks. These are called *task decompositions*. We will first develop a technique to choose the task decomposition

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for which a task assignment can most easily be found. Next, we will look at how the constraint problem can be distributed among agents in the AOSN so that tasks can be assigned more quickly.

WORK COMPLETED

- Contract nets have been analyzed to give a list of features of situations in which the organizational structure should or should not be applied. This work, along with the analysis of several other structures, will form the basis for the vocabulary for characterizing situations.
- A technique for selecting task decompositions has been implemented for task assignment. We have preliminary results from experiments on small task decomposition trees. We are currently expanding the system to work on larger trees.
- We have implemented two basic constraint satisfaction techniques [4; 5] so that we will be able to compare them for our application.

RESULTS

- Preliminary results from our work on task decomposition suggest that we have a promising method for choosing task decompositions for constraint satisfaction problems.

IMPACT/APPLICATIONS

Our work will have direct application to AOSN control. To be autonomous, AOSNs will need the ability to organize themselves to fit their current mission and environment, and they will need to reoganize when the situation changes. This requires that the AOSN be able to select the right organizational structure for the situation, and that it be able to assign components to tasks appropriately.

The field of distributed artificial intelligence studies how systems can be organized to efficiently and effectively carry out a task. Our work on organization will add to this body of knowledge. Our work on task assignment will impact this area as well as more specific applications such as system configuration and job-shop scheduling. Because we use a constraint-based approach to task assignment, we expect some of the techniques developed for our application to be of interest to basic researchers studying constraint satisfaction.

TRANSITIONS

The preliminary algorithm for task assignment is being used is being used in an ONR-funded project (our related project below) as part of the protocol for organizing and reorganizing AOSNs.

As the work progresses, software and results will be available on the project's World Wide Web page.[1]

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[1]http://cdps.umcs.maine.edu/CoDA

RELATED PROJECTS

An overall approach to organization and reorganization of AOSNs is being explored in collaboration with the Autonomous Undersea Systems Institute (AUSI) in Lee, NH. The overall approach is being specified in a set of protocols so that different techniques can easily be studied for each step in a protocol. The techniques for selecting the organizational structure and for task assignment now provide a concrete mechanism for performing steps in the protocol.

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PUBLICATIONS

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